Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!


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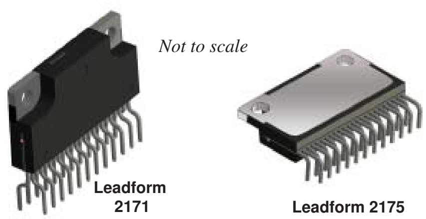
# High Voltage 3-Phase Motor Drivers

## Features and Benefits

- Built-in pre-drive IC
- MOSFET power element
- Alleviate noise generation by adjusting an internal resistor
- CMOS compatible input (5 V)
- High-side gate driver using bootstrap circuit or floating power supply
- Built-in protection circuit for controlling power supply voltage drop (UVLO on VCC)
- Overcurrent protection (OCP), overcurrent limiting (OCL), and thermal shutdown (TSD)
- Output of fault signal during operation of protection circuit
- Output current 1.5, 2.5, or 3 A
- Small SIP (SLA 24-pin)

## Packages: Power SIP




## Description

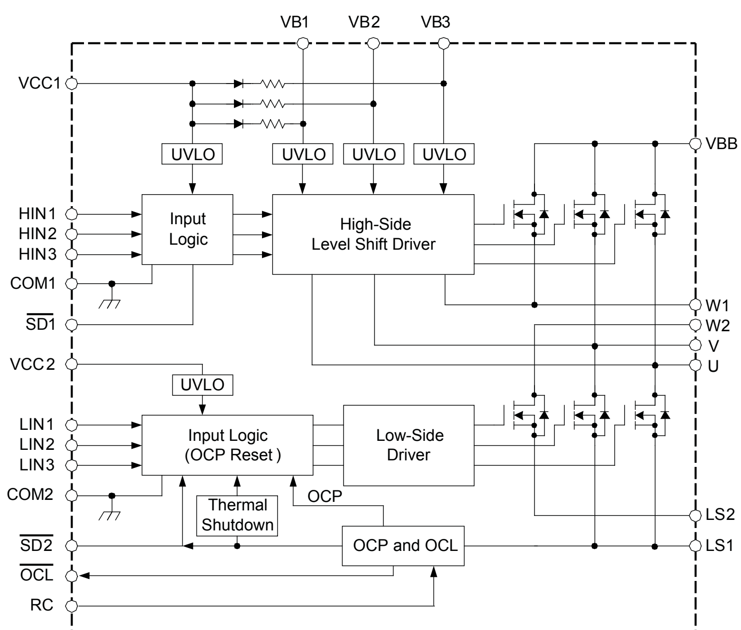
The SLA6868MZ and SLA6870MZ inverter power module (IPM) ICs provide a robust, highly-integrated solution for optimally controlling 3-phase motor power inverter systems and variable speed control systems used in energy-conserving designs to drive motors of residential and commercial appliances. These ICs take 230 VAC input voltage, and up to 3 A (continuous) output current. They can withstand voltages of up to 500 V (MOSFET breakdown voltage).

The SLA power package includes an IC with all of the necessary power elements (six MOSFETs), pre-driver ICs (two), and bootstrap diodes (three), needed to configure the main circuit of an inverter. This enables the main circuit of the inverter to be configured with fewer external components than traditional designs.

Applications include residential white goods (home applications) and commercial appliance motor control:

- Air conditioner fan
- Small ventilation fan
- Dishwasher pump

## Functional Block Diagram




A. $\overline{SD1}$, $\overline{SD2}$ terminals are used for both input and output.
B. $\overline{SD1}$, $\overline{SD2}$, and $\overline{OCL}$ terminals are open-collector output. RC terminal is open-drain input.
C. Blanking Time ($t_{blank}$) is used in Overcurrent Limiting (OCL) and Overcurrent Protection (OCP). If the time exceeds the limit, the signal will be output (open-collector output turns on), and protection operation will start up.

Figure 1. Driver block diagram.



SANKEN ELECTRIC CO., LTD.
http://www.sanken-ele.co.jp/en/

## Selection Guide

| Part Number | MOSFET Breakdown Voltage, $V_{DSS}$(min) (V) | Output Current | |
|---|---|---|---|
| | | Continuous, $I_O$(max) (A) | Pulsed, $I_{OP}$ (max) (A) |
| SLA6868MZ | 500 | 2.5 | 3.75 |
| SLA6870MZ | 500 | 3 | 4.5 |

## Absolute Maximum Ratings, valid at $T_A$ = 25°C

| Characteristic | Symbol | Remarks | | Rating | Unit |
|---|---|---|---|---|---|
| MOSFET Breakdown Voltage | $V_{DSS}$ | $V_{CC}$ = 15 V, $I_D$ = 100 μA, $V_{IN}$ = 0 V | | 500 | V |
| Logic Supply Voltage | $V_{CC}$ | Between VCC and COM | | 20 | V |
| Bootstrap Voltage | $V_{BS}$ | Between VB and HS (U,V, and W phases) | | 20 | V |
| Output Current, Continuous | $I_O$ | SLA6868MZ | | 2.5 | A |
| | | SLA6870MZ | | 3 | A |
| Output Current, Pulsed | $I_{OP}$ | SLA6868MZ | PW ≤ 100 μs, duty cycle = 1% | 3.75 | A |
| | | SLA6870MZ | | 4.5 | A |
| Input Voltage | $V_{IN}$ | HINx and LINx pins | | –0.5 to 7 | V |
| Pull-up Voltage for Shutdown Pins | $V_{SDX}$ | $\overline{\text{SDx}}$ pins | | 7 | V |
| Pull-up Voltage for Overcurrent Limiting Pin | $V_{OCL}$ | | | 7 | V |
| Allowable Power Dissipation | $P_D$ | $T_C$ = 25°C | | 32.9 | W |
| Thermal Resistance (Junction to Case) | $R_{\theta JC}$ | All elements operating | | 3.8 | °C/W |
| Case Operating Temperature | $T_{COP}$ | | | –20 to 100 | °C |
| Junction Temperature (MOSFET) | $T_J$ | | | 150 | °C |
| Storage Temperature | $T_{stg}$ | | | –40 to 150 | °C |

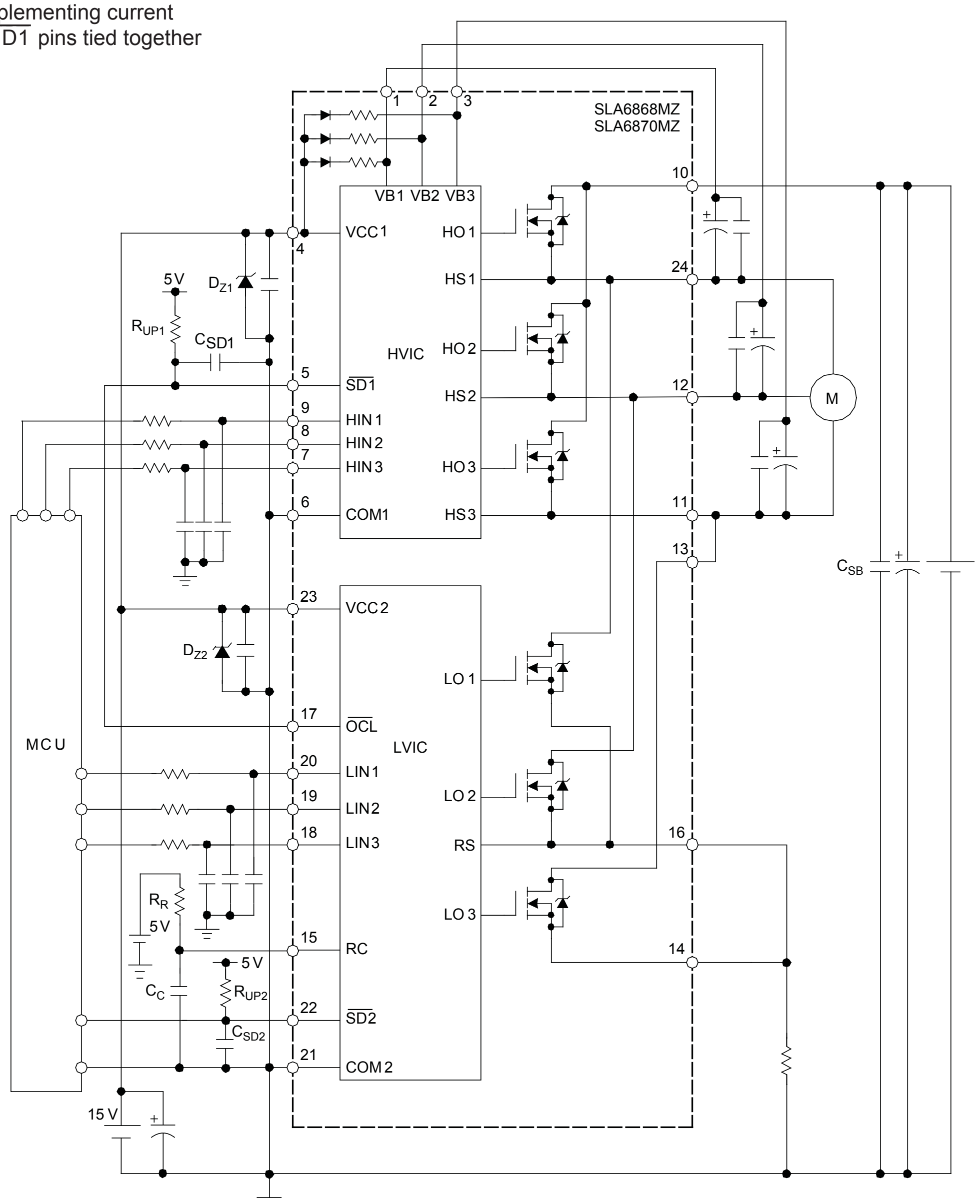
All performance characteristics given are typical values for circuit or system baseline design only and are at the nominal operating voltage and an ambient temperature, $T_A$, of 25°C, unless otherwise stated.

### Recommended Operating Conditions

| Characteristic | Symbol | Remarks | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Main Supply Voltage | $V_{BB}$ | Between VBB and LS | – | – | 400 | V |
| $V_{BB}$ Snubber Capacitor | $C_{SB}$ | | 0.01 | – | 0.1 | μF |
| Logic Supply Voltage | $V_{CC}$ | Between VCC and COM | 13.5 | 15 | 16.5 | V |
| Zener Voltage for VCCx Pins | $V_Z$ | Between VCC and COM | 18 | – | 20 | V |
| Pull-up Voltage | $V_{SDx}$, $V_{OCL}$ | | 4.5 | 5 | 5.5 | V |
| Pull-up Resistor $\overline{\text{SDx}}$ Pins | $R_{UP2}$ | | 3.3 | – | 10 | kΩ |
| Pull-up Resistor OCL Pin | $R_{UP1}$ | | 1 | – | 10 | kΩ |
| Pull-up Resistor RC Pin | $R_R$ | | 33 | – | 390 | kΩ |
| Capacitor $\overline{\text{SDx}}$ Pins | $C_{SDX}$ | | 1 | – | 10 | nF |
| Capacitor RC Pin | $C_C$ | | 1 | – | 4.7 | nF |
| Dead Time | $t_{dead}$ | $T_J$ = –20°C to 150°C | 1.5 | – | – | μs |
| Minimum Input Pulse Width | $I_{INMIN(on)}$ | $T_J$ = –20°C to 150°C | 0.5 | – | – | μs |
| | $I_{INMIN(off)}$ | $T_J$ = –20°C to 150°C | 0.5 | – | – | μs |
| Switching Frequency | $f_{PWM}$ | | – | – | 20 | kHz |

## Typical Application Diagram

Shows configuration for implementing current limiter function: $\overline{OCL}$ and $\overline{SD1}$ pins tied together

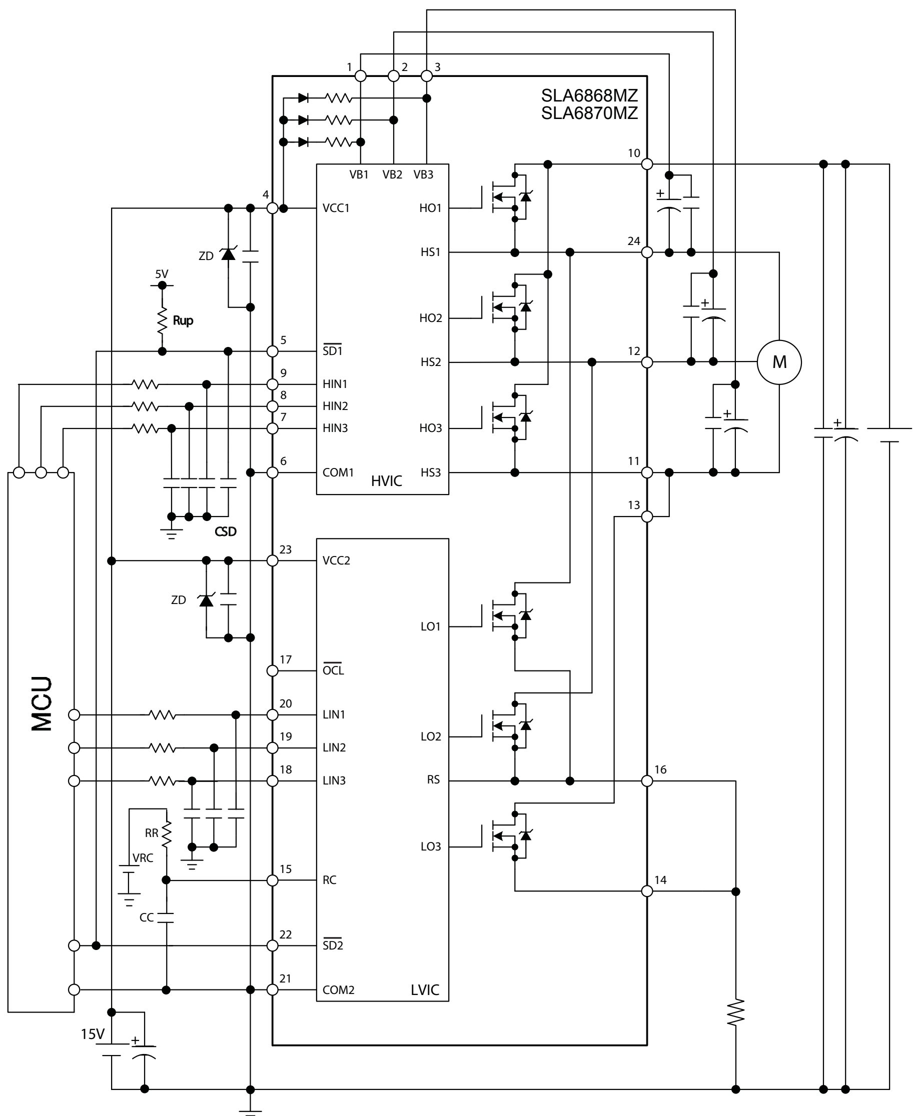



NOTE:

- The external electrolytic capacitors should be placed as close to the IC as possible, in order to avoid malfunctions from external noise interference. Put a ceramic capacitor in parallel with the electrolytic capacitor if further reduction of noise susceptibility is necessary.

### Typical Application Diagram

Shows configuration without current limiter function: $\overline{SD1}$ and $\overline{SD2}$ pins tied together




NOTE:
The external electrolytic capacitors should be placed as close to the IC as possible, in order to avoid malfunctions from external noise interference. Put a ceramic capacitor in parallel with the electrolytic capacitor if further reduction of noise susceptibility is necessary.

**ELECTRICAL CHARACTERISTICS, valid at $T_A$=25°C, unless otherwise noted**

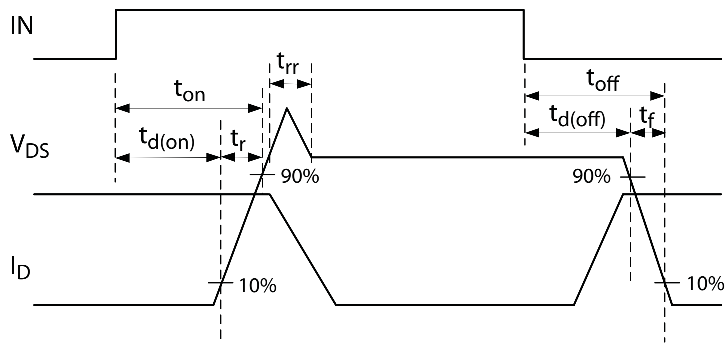
| Characteristics | Symbol | Conditions | | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|---|
| Logic Supply Current | $I_{CC}$ | SLA6868MZ | $V_{CC}$ = 15 V, $T_C$ = –20°C to 125°C | – | 4.2 | 7 | mA |
| | | SLA6870MZ | | – | 2.7 | 5.0 | mA |
| Bootstrap Supply Current | $I_{BX}$ | $V_{BX}$ = 15 V, $V_{HIN}$ = 5 V | | – | 135 | 380 | μA |
| Input Voltage | $V_{IH}$ | $V_{CC}$ = 15 V | | – | 2.9 | 3.4 | V |
| | $V_{IL}$ | $V_{CC}$ = 15 V | | 1.6 | 2.1 | – | V |
| Input Voltage Hysteresis | $V_{Ihys}$ | $V_{CC}$ = 15 V | | – | 0.8 | – | V |
| Input Current | $I_{IN}$ | $V_{IN}$ = 5 V | | – | 230 | 500 | μA |
| Undervoltage Lock Out | $V_{UVHL}$ | High side, between VBx and U, V, or W | | 9.0 | 10.0 | 11.0 | V |
| | $V_{UVHH}$ | | | 9.5 | 10.5 | 11.5 | V |
| | $V_{UVHhys}$ | High side, hysteresis | | – | 0.5 | – | V |
| | $V_{UVLL}$ | Low side, between VCC2 and COM2 | | 10.0 | 11.0 | 12.0 | V |
| | $V_{UVLH}$ | | | 10.5 | 11.5 | 12.5 | V |
| | $V_{UVLhys}$ | Low side, hysteresis | | – | 0.5 | – | V |
| SDx and OCL Output Voltage | $V_{SDX(on)}$, $V_{OCL}$ | $V_{SDX}$ = $V_{OCL}$ = 5 V, $R_{UPX}$ = 3.3 kΩ | | – | – | 0.6 | V |
| Overtemperature Detection Threshold Temperature (Activation and Deactivation) | $T_{DH}$ | $V_{CC}$ = 15 V, high-side and low side | | 120 | 135 | 150 | °C |
| | $T_{DL}$ | | | 100 | 115 | 130 | °C |
| | $T_{Dhys}$ | | | – | 20 | – | °C |
| Overcurrent Protection Trip Voltage | $V_{TRIP}$ | $V_{CC}$ = 15 V | | 0.9 | 1.0 | 1.1 | V |
| Overcurrent Limit Reference Voltage | $V_{LIM}$ | $V_{CC}$ = 15 V | | 0.5035 | 0.53 | 0.5565 | V |
| Overcurrent Protection Hold Time | $t_p$ | $V_{RC}$ = 5 V, $R_R$ = 360 kΩ, $C_C$ = 0.0047 μF | | – | 2.0 | – | ms |
| Blanking Time | $t_{blank}$ | $V_{CC}$ = 15 V | | 1.4 | 2.0 | 2.6 | μs |
| Bootstrap Diode Leakage Current | $I_{LBD}$ | $V_R$ = 250 V | | – | – | 10 | μA |
| Bootstrap Diode Forward Voltage | $V_{FBD}$ | SLA6868MZ | $I_F$ = 0.05 A | – | 1.1 | 1.3 | V |
| | | SLA6870MZ | | – | 0.8 | 1.3 | V |
| Bootstrap Diode Recovery Time | $t_{rrb}$ | $I_F$ / $I_{RP}$ = 100 mA / 100 mA | | – | 70 | – | ns |
| Bootstrap Diode Series Resistor | $R_{BD}$ | | | 168 | 210 | 252 | Ω |
| MOSFET Breakdown Voltage | $V_{DSS}$ | $V_{CC}$ = 15 V, $I_D$ = 100 μA, $V_{IN}$ = 0 V | | 500 | – | – | V |
| MOSFET Leakage Current | $I_{DSS}$ | $V_{CC}$ = 15 V, $V_{DS}$ = 500 V, $V_{IN}$ = 0 V | | – | – | 100 | μA |
| MOSFET On State Resistance | $R_{DS(on)}$ | SLA6868MZ | $V_{CC}$ = 15 V, $I_D$ = 1.5 A, $V_{IN}$ = 5 V | – | 2.0 | 2.4 | Ω |
| | | SLA6870MZ | $V_{CC}$ = 15 V, $I_D$ = 1.25 A, $V_{IN}$ = 5 V | – | 1.4 | 1.7 | Ω |
| MOSFET Diode Forward Voltage | $V_{SDF}$ | SLA6868MZ | $V_{CC}$ = 15 V, $I_{SD}$ = 1.5 A, $V_{IN}$ = 0 V | – | 1.1 | 1.5 | V |
| | | SLA6870MZ | $V_{CC}$ = 15 V, $I_{SD}$ = 1.25 A, $V_{IN}$ = 0 V | – | 1.0 | 1.5 | V |

**SLA6868MZ SWITCHING CHARACTERISTICS, valid at $T_A$=25°C, unless otherwise noted**

| Characteristics | Symbol | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Switching Time, High Side | $t_{dH(on)}$ | $V_{BB}$ = 300 V, $V_{CC}$ = 15 V, $I_D$ = 2.5 A, 0 V ≤ $V_{IN}$ ≤ 5 V | – | 790 | – | ns |
| | $t_{rH}$ | | – | 60 | – | ns |
| | $t_{rrH}$ | | – | 115 | – | ns |
| | $t_{dH(off)}$ | | – | 725 | – | ns |
| | $t_{fH}$ | | – | 20 | – | ns |
| Switching Time, Low Side | $t_{dL(on)}$ | $V_{BB}$ = 300 V, $V_{CC}$ = 15 V, $I_D$ = 2.5 A, 0 V ≤ $V_{IN}$ ≤ 5 V | – | 680 | – | ns |
| | $t_{rL}$ | | – | 70 | – | ns |
| | $t_{rrL}$ | | – | 120 | – | ns |
| | $t_{dL(off)}$ | | – | 605 | – | ns |
| | $t_{fL}$ | | – | 20 | – | ns |

**SLA6870MZ SWITCHING CHARACTERISTICS, valid at $T_A$=25°C, unless otherwise noted**

| Characteristics | Symbol | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Switching Time, High Side | $t_{dH(on)}$ | $V_{BB}$ = 300 V, $V_{CC}$ = 15 V, $I_D$ = 2.5 A, 0 V ≤ $V_{IN}$ ≤ 5 V, inductive load | – | 755 | – | ns |
| | $t_{rH}$ | | – | 65 | – | ns |
| | $t_{rrH}$ | | – | 100 | – | ns |
| | $t_{dH(off)}$ | | – | 680 | – | ns |
| | $t_{fH}$ | | – | 15 | – | ns |
| Switching Time, Low Side | $t_{dL(on)}$ | $V_{BB}$ = 300 V, $V_{CC}$ = 15 V, $I_D$ = 2.5 A, 0 V ≤ $V_{IN}$ ≤ 5 V, inductive load | – | 645 | – | ns |
| | $t_{rL}$ | | – | 70 | – | ns |
| | $t_{rrL}$ | | – | 105 | – | ns |
| | $t_{dL(off)}$ | | – | 560 | – | ns |
| | $t_{fL}$ | | – | 20 | – | ns |




Switching Characteristics Definitions

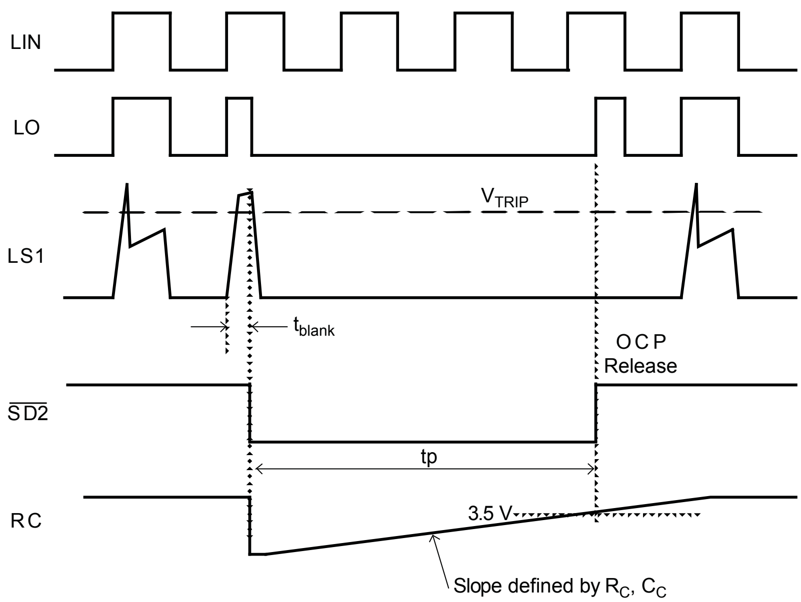
**Truth Table**

| Mode | Hin | Lin | H-side MOSFET | L-side MOSFET |
|---|---|---|---|---|
| Normal | L | L | Off | Off |
| | H | L | On | Off |
| | L | H | Off | On |
| | H | H | On | On |
| TSD | L | L | Off | Off |
| | H | L | On | Off |
| | L | H | Off | Off |
| | H | H | On | Off |
| OCP | L | L | Off | Off |
| | H | L | On | Off |
| | L | H | Off | Off |
| | H | H | On | Off |
| $\overline{\text{OCL}}$ (= L)[1] | L | L | Off | Off |
| | H | L | Off | Off |
| | L | H | Off | On |
| | H | H | Off | On |
| UVLO (VCC)[2] | L | L | Off | Off |
| | H | L | Off | Off |
| | L | H | Off | Off |
| | H | H | Off | Off |
| UVLO (VB)[3] | L | L | Off | Off |
| | H | L | Off | Off |
| | L | H | Off | On |
| | H | H | Off | On |
| $\overline{\text{SD2}}$ (= L) | L | L | Off | Off |
| | H | L | On | Off |
| | L | H | Off | Off |
| | H | H | On | Off |

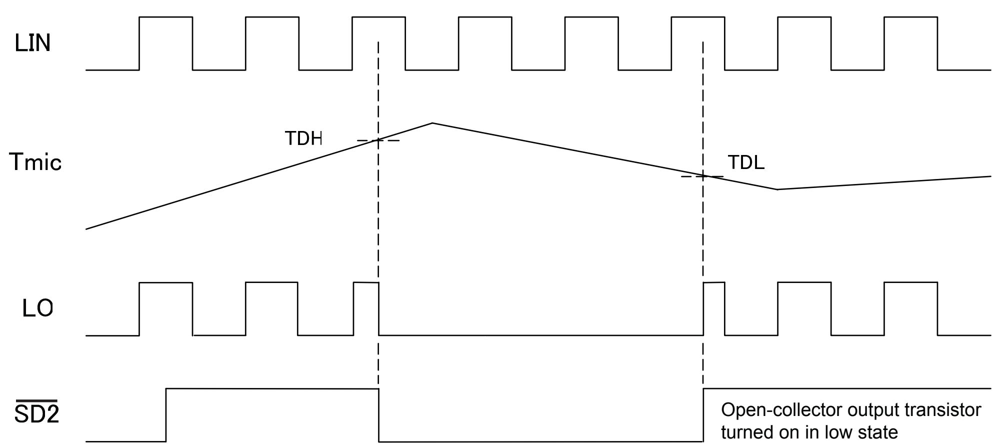
[1]The OCL feature is enabled when the $\overline{\text{OCL}}$ and $\overline{\text{SD1}}$ pins are tied together externally. If these pins are not tied when an OCL condition occurs, device operation continues in Normal mode.
[2]Returning to the Normal mode of operation from a $V_{CC}$ UVLO condition, a high-side MOSFET resumes switching on the rising edge of an HINx input. On the other hand, a low-side MOSFET resumes switching on the first logic high of a LINx input after release of the UVLO condition.
[3]Returning to the Normal mode of operation from a $V_B$ UVLO condition, a high-side MOSFET resumes switching on the rising edge of an HINx input.

Note: To prevent a shoot-through condition, the external microcontroller should not drive HINx = LINx = H at the same time.

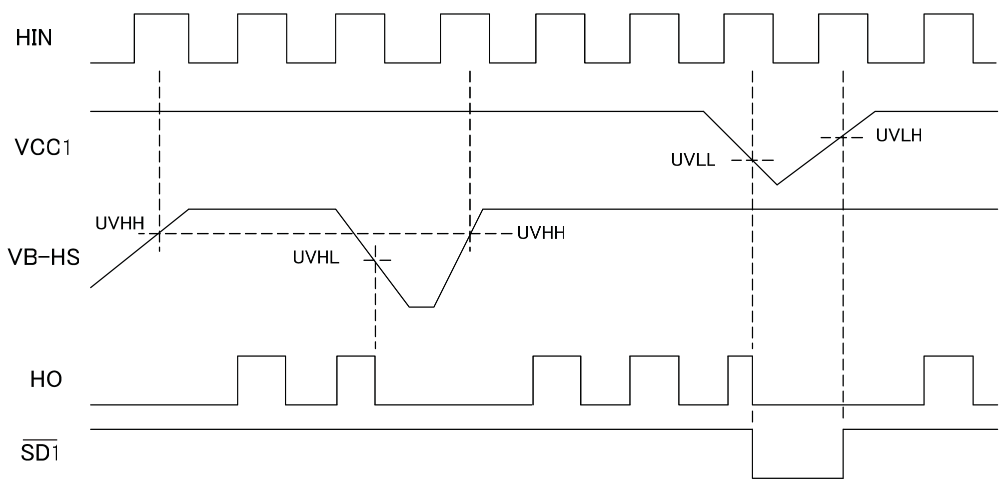
**OCP Timing Diagram**



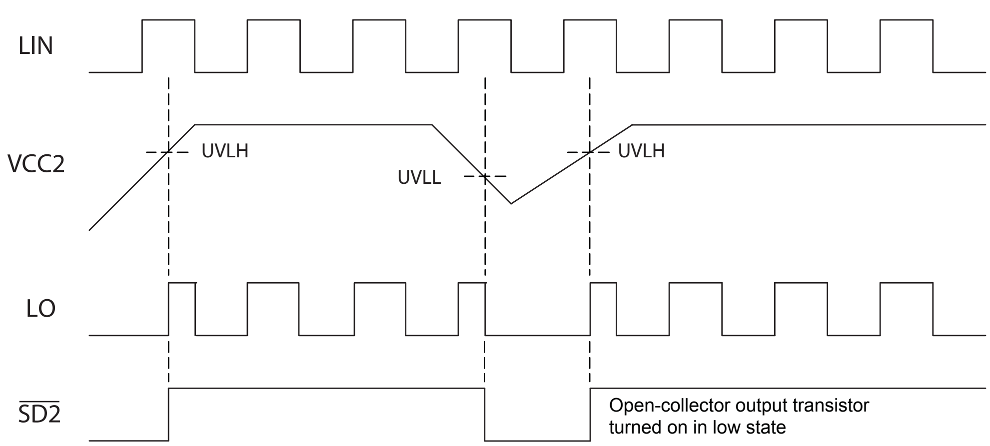

**Low-Side TSD Timing Diagram**



**High-Side UVLO Timing Diagram**

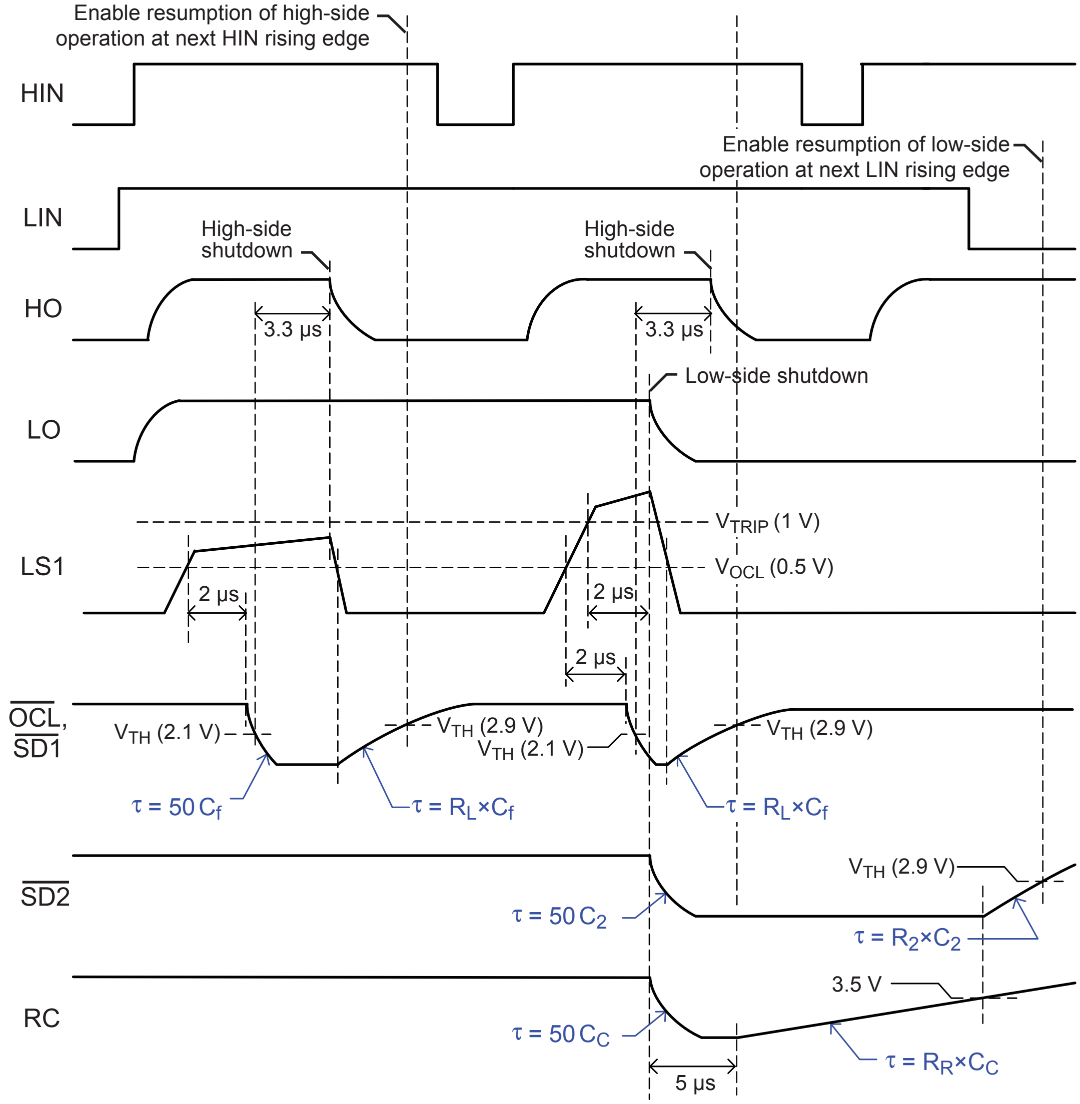



**Low-Side UVLO Timing Diagram**



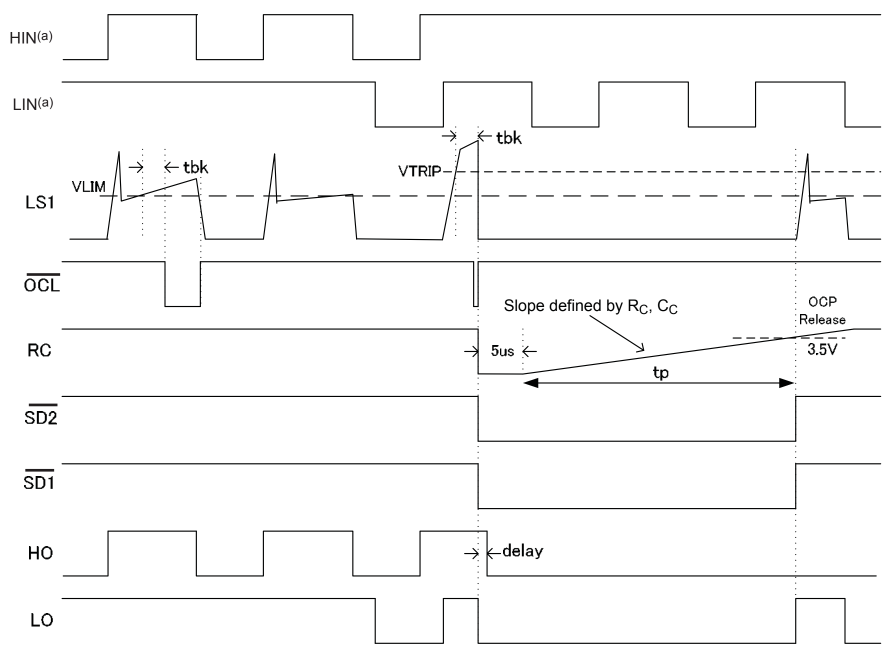
**OCL Timing Diagram**

$\overline{\text{OCL}}$ and $\overline{\text{SD1}}$ pins connected externally



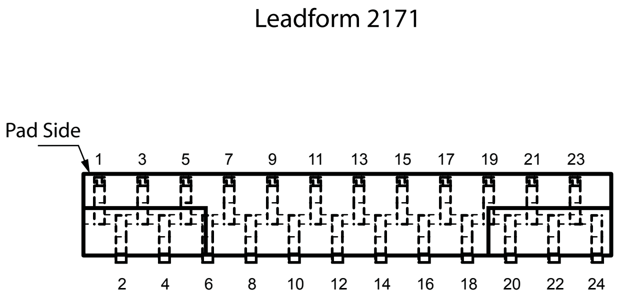
### Shut Down Timing Diagram

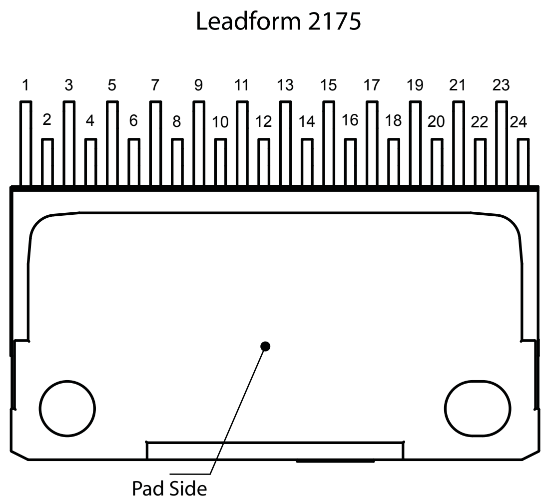
$\overline{SD1}$ and $\overline{SD2}$ pins connected externally; current-limiter function not in use




(a) Each HINx or LINx pin drives a independent side of a phase, that is, the high-side and the low-side swtiching devices of a U, V, or W motor coil phase are each driven separately, by the corresponding dedicated HINx or LINx input

## Pin-out Diagram



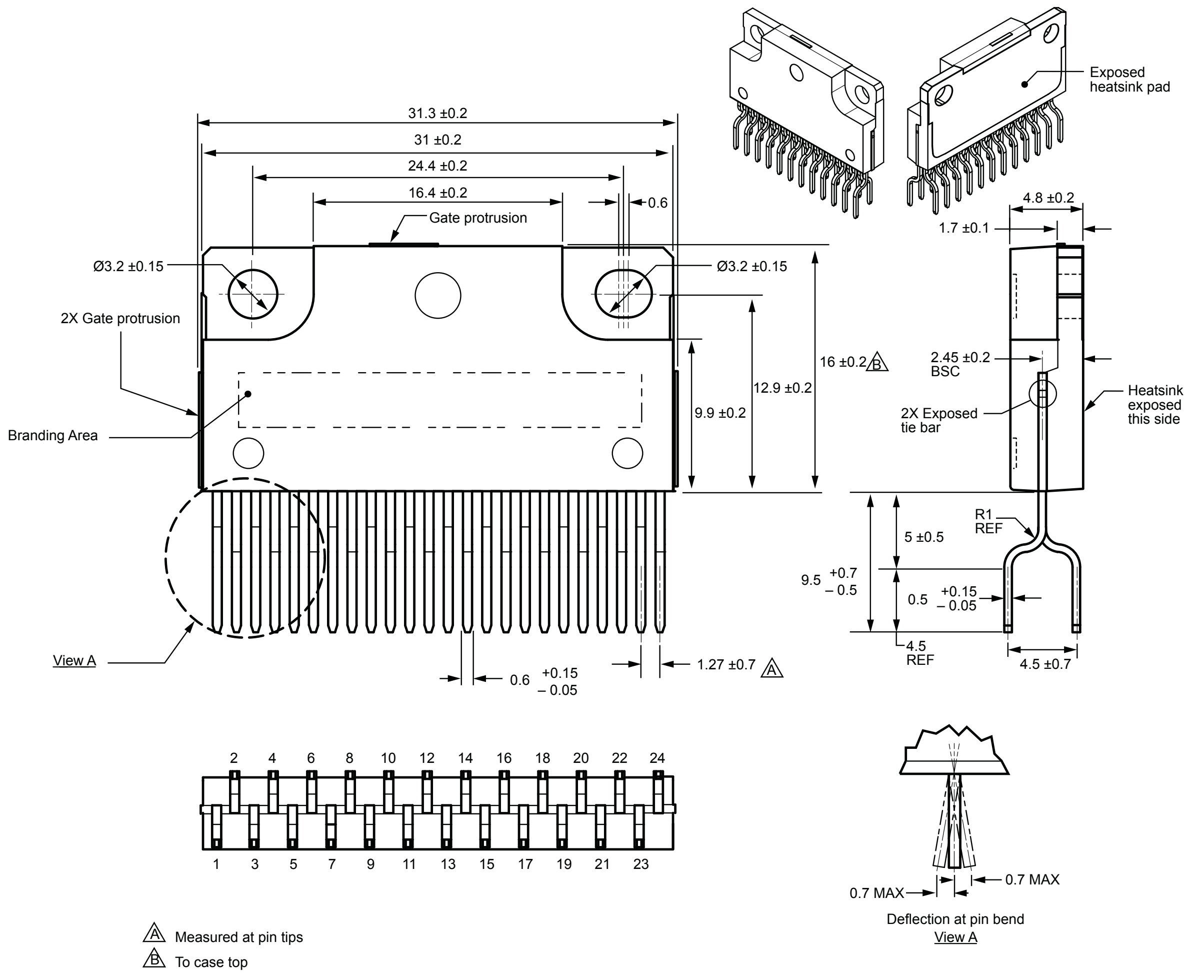

### Terminal List Table

| Number | Name | Function |
|---|---|---|
| 1 | VB1 | High side bootstrap terminal (U phase) |
| 2 | VB2 | High side bootstrap terminal (V phase) |
| 3 | VB3 | High side bootstrap terminal (W phase) |
| 4 | VCC1 | High side logic supply voltage |
| 5 | $\overline{\text{SD1}}$ | High side shutdown input and UVLO fault signal output |
| 6 | COM1 | High side logic GND terminal |
| 7 | HIN3 | High side input terminal (W phase) |
| 8 | HIN2 | High side input terminal (V phase) |
| 9 | HIN1 | High side input terminal (U phase) |
| 10 | VBB | Main supply voltage |
| 11 | W1 | Output of W phase (connect to W2 externally) |
| 12 | V | Output of V phase |
| 13 | W2 | Output of W phase (connect to W1 externally) |
| 14 | LS2 | Low side source terminal (connect to LS1 externally) |
| 15 | RC | Overcurrent protection hold time adjustment input terminal |
| 16 | LS1 | Low side source terminal (connect to LS2 externally) |
| 17 | $\overline{\text{OCL}}$ | Output for overcurrent limiting |
| 18 | LIN3 | Low side input terminal (W phase) |
| 19 | LIN2 | Low side input terminal (V phase) |
| 20 | LIN1 | Low side input terminal (U phase) |
| 21 | COM2 | Low side GND terminal |
| 22 | $\overline{\text{SD2}}$ | Low side shutdown input and overtemperature, overcurrent, and UVLO fault signals output |
| 23 | VCC2 | Low side logic supply voltage |
| 24 | U | Output of U phase |

## Package Outline Drawing

### Leadform 2171

Dual rows, 24 alternating pins; vertical case mounting; pin #1 on pad side




Leadform: 2171
Terminal core material: Cu
Terminal plating: Ni
Recommended attachment: Solder dip (Sn-Ag-Cu)

Dimensions in millimeters

Branding codes (exact appearance at manufacturer discretion):
1st line, type: SLA6868MZ or SLA6870MZ

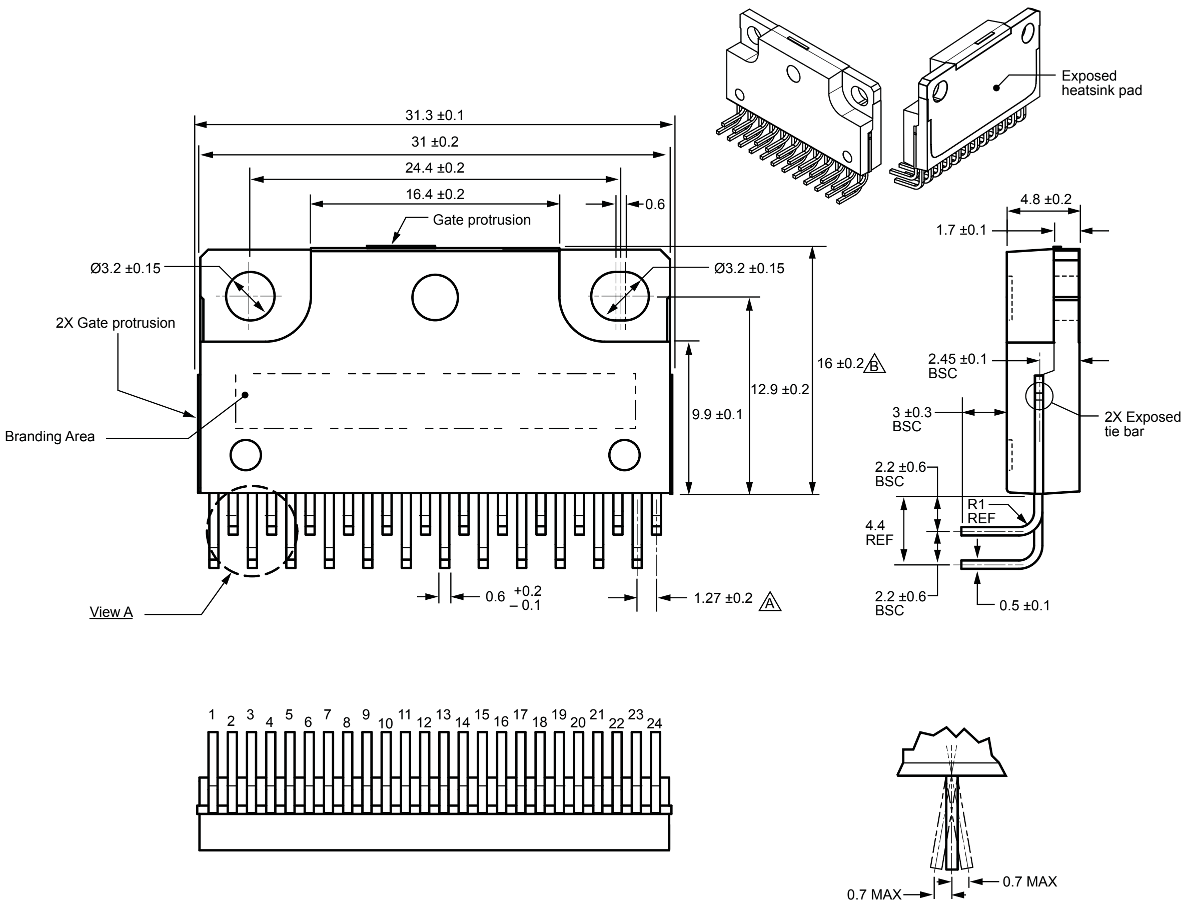
2nd line, lot: *YMDD#*
Where: Y is the last digit of the year of manufacture
M is the month (*1* to *9, O, N, D*)
DD is the date
\# is the tracking letter

*Leadframe plating Pb-free. Device composition complies with the RoHS directive.*

## Package Outline Drawing

Leadform 2175

Dual rows, 24 alternating pins; pins bent 90° for horizontal case mounting; pin #1 in outer row




Deflection at pin bend
View A

A Measured at pin exit from case

B To case top

Leadform: 2175
Terminal core material: Cu
Terminal plating: Ni
Recommended attachment: Solder dip (Sn-Ag-Cu)

Dimensions in millimeters

Branding codes (exact appearance at manufacturer discretion):
1st line, type: SLA6868MZ or SLA6870MZ

2nd line, lot: *YMDD*#
Where: Y is the last digit of the year of manufacture
M is the month (*1* to *9, O, N, D*)
DD is the date
# is the tracking letter

*Leadframe plating Pb-free. Device composition complies with the RoHS directive.*

Because reliability can be affected adversely by improper storage environments and handling methods, please observe the following cautions.

**Cautions for Storage**

- Ensure that storage conditions comply with the standard temperature (5°C to 35°C) and the standard relative humidity (around 40% to 75%); avoid storage locations that experience extreme changes in temperature or humidity.
- Avoid locations where dust or harmful gases are present and avoid direct sunlight.
- Reinspect for rust on leads and solderability of the products that have been stored for a long time.

**Cautions for Testing and Handling**

When tests are carried out during inspection testing and other standard test periods, protect the products from power surges from the testing device, shorts between the product pins, and wrong connections. Ensure all test parameters are within the ratings specified by Sanken for the products.

**Remarks About Using Silicone Grease with a Heatsink**

- When silicone grease is used in mounting the products on a heatsink, it shall be applied evenly and thinly. If more silicone grease than required is applied, it may produce excess stress.
- Volatile-type silicone greases may crack after long periods of time, resulting in reduced heat radiation effect. Silicone greases with low consistency (hard grease) may cause cracks in the mold resin when screwing the products to a heatsink.

  Our recommended silicone greases for heat radiation purposes, which will not cause any adverse effect on the product life, are indicated below:

| Type | Suppliers |
|---|---|
| G746 | Shin-Etsu Chemical Co., Ltd. |
| YG6260 | Momentive Performance Materials Inc. |
| SC102 | Dow Corning Toray Co., Ltd. |

**Cautions for Mounting to a Heatsink**

- When the flatness around the screw hole is insufficient, such as when mounting the products to a heatsink that has an extruded (burred) screw hole, the products can be damaged, even with a lower than recommended screw torque. For mounting the products, the mounting surface flatness should be 0.05 mm or less.
- Please select suitable screws for the product shape. Do not use a flat-head machine screw because of the stress to the products. Self-tapping screws are not recommended. When using self-tapping screws, the screw may enter the hole diagonally, not vertically, depending on the conditions of hole before threading or the work situation. That may stress the products and may cause failures.
- Recommended screw torque: 0.588 to 0.785 N●m (6 to 8 kgf●cm).
- For tightening screws, if a tightening tool (such as a driver) hits the products, the package may crack, and internal stress fractures may occur, which shorten the lifetime of the electrical elements and can cause catastrophic failure. Tightening with an air driver makes a substantial impact. In addition, a screw torque higher than the set torque can be applied and the package may be damaged. Therefore, an electric driver is recommended.

  When the package is tightened at two or more places, first pre-tighten with a lower torque at all places, then tighten with the specified torque. When using a power driver, torque control is mandatory.

**Soldering**

- When soldering the products, please be sure to minimize the working time, within the following limits:
  260±5°C  10±1 s  (Flow, 2 times)
  380±10°C  5±0.5 s (Soldering iron, 1 time)
- Soldering should be at a distance of at least 1.5 mm from the body of the products.

**Electrostatic Discharge**

- When handling the products, the operator must be grounded. Grounded wrist straps worn should have at least 1 MΩ of resistance from the operator to ground to prevent shock hazard, and it should be placed near the operator.
- Workbenches where the products are handled should be grounded and be provided with conductive table and floor mats.
- When using measuring equipment such as a curve tracer, the equipment should be grounded.
- When soldering the products, the head of soldering irons or the solder bath must be grounded in order to prevent leak voltages generated by them from being applied to the products.
- The products should always be stored and transported in Sanken shipping containers or conductive containers, or be wrapped in aluminum foil.